



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/819,552	03/28/2001	Calvin T. Gabriel	39153/310 (F0797)	3369

7590 05/04/2004

Katherine D. Lee
FOLEY & LARDNER
Firststar Center
777 East Wisconsin Avenue
Milwaukee, WI 53202-5367

EXAMINER

TRAN, BINH X

ART UNIT	PAPER NUMBER
----------	--------------

1765

DATE MAILED: 05/04/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/819,552

Applicant(s)

GABRIEL ET AL.

Examiner

Binh X Tran

Art Unit

1765

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 06 February 2004.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-15 and 24-31 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 1 and 4-6 is/are allowed.
- 6) ☒ Claim(s) 7, 8, 11-14, 24-26, 29-31 is/are rejected.
- 7) ☒ Claim(s) 2, 3, 9, 10, 15, 27 and 28 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Objections

1. Claims 2-3 are objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form.

In claim 2, applicants claim that "the plasma is a fluorine-based plasma". This limitation fail to further limit the subject mater of previous claim (i.e. claim 1) because applicants already discloses that the "plasma including fluorine" in claim 1. Claim 3 is objected because it depends on claim 2.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

3. Claims 7, 12, 14 are rejected under 35 U.S.C. 102(e) as being anticipated by Shen et al. (US 6,271,154)

The applied reference has a common assignee with the instant application.

Based upon the earlier effective U.S. filing date of the reference, it constitutes prior art

under 35 U.S.C. 102(e). This rejection under 35 U.S.C. 102(e) might be overcome either by a showing under 37 CFR 1.132 that any invention disclosed but not claimed in the reference was derived from the inventor of this application and is thus not the invention "by another," or by an appropriate showing under 37 CFR 1.131.

Respect to claim 7, Shen discloses the process comprising the steps of:

patterning a feature on a photoresist layer (16') disposed over a substrate, the feature patterned in accordance with a pattern provided on a mask with UV radiation (col. 4 lines 53-67);

developing the photoresist layer, the patterned photoresist layer including at least one feature having a top surface and side surface (Fig 4);

exposing the photoresist layer to an argon densifier (col. 5 lines 20-45)

transforming the top surface and side surface with the densifier to form a hardened surface (40) (Fig 5);

etching the substrate in accordance with the transformed feature, wherein the exposing step occurs after the developing step and before the etching step (fig 6).

Shen does not explicitly disclose that the etch stability of the feature is a function of the hardened surface. However, Shen discloses identical process steps and uses the same material as applicants' invention. The examiner therefore concludes that it is inherently that etch stability of the feature is a function of the hardened surface in Shen's reference. Further, the MPEP 2112 states, "The claiming of a new use, new function or unknown property which is inherently present in the prior art does not necessarily make the claim patentable".

Respect to claim 12, Shen discloses the densifier is an ion implantation (col. 4 lines 35-45). Respect to claim 14, Shen discloses the transforming step include the densification or cross-link of the top surface and side surface to form the harden surface (col. 5-6).

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

6. Claims 7-8, 11-14, 24-26, 29, 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ng (US 5,876,903) in view of Sato et al. (US 6,054,254).

Respect to claim 7, Ng discloses the process comprising the steps of:
patterning a feature on a photoresist layer (70) disposed over a substrate, the

feature patterned in according with a patterned provided on a mask (74) with UV radiation (col. 1 lines 20-24 and col. 4 lines 15-34, Fig 7);

developing the photoresist layer, the patterned photoresist layer including at least one feature having a top surface and side surface (Fig 8);

exposing the photoresist layer to a argon densifier (col. 4 lines 35-45)

transforming the top surface and side surface with the densifier to form a harden surface (86) (Fig 9);

etching the substrate in according the transform feature, wherein the exposing step occurs after the developing step and before the etching and etch stability is due to the harden surface (86).

Ng does not explicitly disclose the radiation is at deep UV. However, Ng clearly discloses the radiation is at UV wavelength (col. 1 lines 20-05). Sato discloses the radiation is at 248 nm or 222 nm (read on "deep ultraviolet"; col. 49 lines 5-15). It would have been obvious to one having ordinary skill in the art, at the time of invention, to perform at deep UV radiation because this would create a fine pattern dimension.

Respect to claims 8 and 24, Ng fails to disclose the specific thickness of the photoresist layer. In a semiconductor process, Sato discloses a photoresist layer (8) having a thickness of 200 nm is sufficient to act as a mask (col. 74 lines 17-21; Note: 200 nm = 0.2 μm ; read on "thickness less than 0.25 μm "). It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Ng in view of Sato by having the thickness less than 0.25 μm because it would be sufficient to act as a mask.

Respect to claim 11, Sato discloses the densifier is performed using ArF excimer laser (col. 77 lines 23-30). Sato also teaches that electron beam can be used to substitute for ArF laser (col. 49 lines 10-16). It would have been obvious to one having ordinary skill in the art, at the time of invention, to use electron beam because equivalent and substitution of one for the other would produce an expected result.

Respect to claim 12, Ng discloses the densifier is an ion implantation (col. 4 lines 35-45). Respect to claim 14, Ng discloses the transforming step include the densification of the top surface and side surface to form the harden surface (86).

Respect to claims 13, 25, Sato discloses the thickness or depth of the transforming photoresist layer is result effective variable. The result effective variables are commonly determined by routine experiment. Sato discloses the photoresist pattern is about 10 nm or less (col. 75 lines 25-30) in one example. The process of conducting routine experiments so as to produce an expected result is obvious to one of ordinary skill in the art. Hence, it would have been obvious to one having ordinary skill in the art, at the time of invention, to perform routine experiments to obtain optimal values as an expected result.

Respect to claim 26, Ng discloses the exposed surfaces comprises a top surface and side surface of the feature (Figure 8-9). . Respect to claim 29, Sato discloses the photoresist layer contains phenolic resin (col. 82 lines 45-47). Respect to claim 31, Ng discloses the feature is a via structure or a trench (Fig 10).

7. Claims 24-29 and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dunne et al. (US 6,207,583) in view of Sato.

Respect to claim 24, Dunne discloses a method comprising of using a feature on the photoresist layer (18) disposed above a layer or a substrate, the feature was lithographically patterned using a ultraviolet wavelength (col. 6 lines 1-5, Fig 1c, Fig 5a);:

transforming the exposed surface to be structurally denser (i.e. shell 22 or 43) than the un-treated region form a shell (22 or 43) using fluorine implantation (col. 8, Fig 1d, Fig 5b);

etching the layer of the substrate according to the feature (Fig 1d, 5b).

Dunne fails to disclose the specific thickness of the photoresist layer. In a semiconductor process, Sato discloses a photoresist layer (8) having a thickness of 200 nm is sufficient to act as a mask (col. 74 lines 17-21; Note: 200 nm = 0.2 μ m; read on "thickness less than 0.25 μ m"). It would have been obvious to one having ordinary skill in the art, at the time of invention, to modify Dunne in view of Sato by having the thickness less than 0.25 μ m because it would be sufficient to act as a mask.

Dunne also does not explicitly disclose the radiation is at deep UV. However, Dunne clearly discloses the radiation is at UV wavelength. Sato discloses the radiation is at 248 nm or 222 nm (read on "deep ultraviolet"; col. 49 lines 5-15). It would have been obvious to one having ordinary skill in the art, at the time of invention, to perform at deep UV radiation because this would create a fine pattern dimension.

Respect to claim 25, 28 the cited prior arts differ from the invention by the specific value depth values. However, Dunne clearly discloses that flow rate, pressure, RF power, temperature, etch stability is a result effective variable. Sato discloses the

Art Unit: 1765

thickness or depth of the transforming photoresist layer is also result effective variable having a depth of 10 nm or less (col. 75 lines 25-30). The result effective variables are commonly determined by routine experiment. The process of conducting routine experiments so as to produce an expected result is obvious to one of ordinary skill in the art. Hence, it would have been obvious to one having ordinary skill in the art, at the time of invention, to perform routine experiments to obtain optimal values as an expected result.

Respect to claim 26, Dunne teaches the exposed surfaces comprise a top surface and side surfaces. Respect to claim 27, Dunne teaches the exposed surface (23 or 43) are structurally denser due to the fluorination using fluorine-base plasma (col. 8).

The limitation of claim 28 has been discussed. Respect to claim 29, Sato discloses the photoresist layer contains phenolic resin (col. 82 lines 45-47). Respect to claim 31, Dunne discloses the feature is via structure (20).

8. Claim 30 is rejected under 35 U.S.C. 103(a) as being unpatentable over Dunne and Sato as applied to claim 24 above, and further in view of Wong et al. (US 6,319,655).

Sato teaches the polymer photoresist is lithographically patterned using 193 nm wavelength (col. 49 lines 10-15). However, Dunne and Sato fail to disclose that the photoresist comprises an acrylate or alicyclic polymer. Wong teaches the photoresist layer comprises acrylate or alicyclic polymer and it is patterned using light at having a wavelength at 193 nm. It would have been obvious to one having ordinary skill in the

art, at the time of invention, to use acrylate or alicyclic polymer because this would increase etch resistance of the photoresist layer.

9. Claim 30 is rejected under 35 U.S.C. 103(a) as being unpatentable over Ng and Sato as applied to claim 24 above, and further in view of Wong et al. (US 6,319,655).

Sato teaches the polymer photoresist is lithographically patterned using 193 nm wavelength (col. 49 lines 10-15). However, Ng and Sato fail to disclose that the photoresist comprises an acrylate or alicyclic polymer. Wong teaches the photoresist layer comprises acrylate or alicyclic polymer and it is patterned using light at having a wavelength at 193 nm. It would have been obvious to one having ordinary skill in the art, at the time of invention, to use acrylate or alicyclic polymer because this would increase etch resistance of the photoresist layer.

Allowable Subject Matter

10. Claims 1, 4-6 are allowed.

11. Claim 3 is objected but would be allowable if rewritten to overcome the objection set forth in this Office action and to include all of the limitations of the base claim and any intervening claims.

12. Claims 9-10, 15, 27-28 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

13. The following is a statement of reasons for the indication of allowable subject matter: The cited prior arts fail to disclose or suggest exposing the photoresist layer to a plasma comprises fluorine-base to form a harden shell before using the photoresist

layer to etch an underlying layer in conjunction with all other limitation in the claim. The closest prior art (Ng and/or Shen) teaches exposing the photoresist layer to inert gas such as argon or nitrogen to form a harden shell before the etching step. Dunne teaches to form the harden surface during the etching step.

Response to Arguments

14. Applicant's arguments, see page 9, filed 02-06-2004, with respect to the rejection(s) of claim(s) 1-6 under 103 rejection have been fully considered and are persuasive. Therefore, the rejection has been withdrawn

Applicant's arguments, see page 9, filed 02-06-2004, with respect to the rejection(s) of claim(s) 7-8 and 11-15 under 103 have been fully considered and are persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of Ng and Sato.

Applicant's arguments filed 02-06-2004 with respect to claims 24-31 have been fully considered but they are not persuasive. Applicants argue that the independent claim 21 is "specifically related to a process in which the photoresist layer is transformed before subsequent etching or doping and implanting step". The examiner disagrees. There is no limitation in claim 24 which require that the transforming step must be performed before the etching step. The examiner interpret "the feature" (in the phrase "etching or doping the layer or substrate according to the feature") is the shape of pattern of the photoresist layer. There is no limitation in the claim indicating that "the feature" must be the photoresist feature after the transforming step. Since the

applicants amend claim 24, the examiner has the right to raise additional new ground of rejection (i.e. 103 rejection over Ng in view of Sato).

Conclusion

15. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

16. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Binh X Tran whose telephone number is (571) 272-1469. The examiner can normally be reached on Monday-Thursday and every other Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine G Norton can be reached on (571) 272-1465. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Binh X. Tran

NADINE G. NORTON
SUPERVISORY PATENT EXAMINER
